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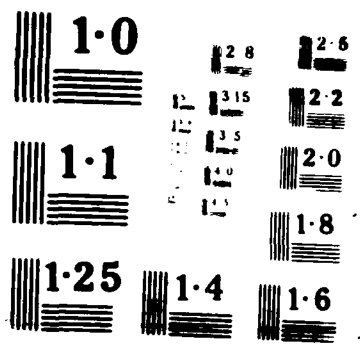
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CENTRAL DENTAL HIGH-VOLUME LABORATORY EVACUATION (HVLE) SYSTEMS

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This report includes the minimum requirements for central dental high-volume laboratory evacuation (HVLE) systems and associated centrally plumbed distribution networks for use in USAF dental health facilities. These specifications were developed through joint evaluations by the Dental Investigation Service and the Occupational and Environmental Health Laboratory. (Reference USAFSAM-TR-86-25, "Dental Laboratory Respiratory Hazards and Vacuum Performance Parameters," Nov 1986.)

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CONTENTS

CENTRAL DENTAL HIGH-VOLUME LABORATORY EVACUATION (HVLE) SYSTEMS

1. INTRODUCTION

1.1 Dental High-Volume Laboratory Evacuation System. The dental high-volume laboratory evacuation system (HVLE) is an independent dental laboratory vacuum system specifically designed for scavenging, collecting, and filtering (for recycling/disposal) of grinding and polishing particulates generated in the dental laboratory. Particulates are those identified by the United States Air Force Occupational and Environmental Health Laboratory (OEHL) and the United States Air Force Dental Investigation Service (DIS). (Reference USAFSAM-TR-86-25, "Dental Laboratory Respiratory Hazards and Vacuum Performance Parameters," Nov 1986).

1.2 Application. The HVLE system described and specified herein applies to composite and free-standing USAF dental facilities containing more than 6 dental treatment rooms (DTRs) with a dental laboratory.

1.3 Components.

1.3.1 The HVLE system shall consist primarily of the following components:

- Remote-controlled and monitored vacuum turbine (turbo-exhauster) with noise and flow controls.

- Central collector/separator/filter unit equipped with cyclonic chamber, filters, filter agitator, and removable solids collector.

1.3.2 The HVLE central distribution network shall consist primarily of the following components:

- Smooth-bore plastic piping.
- Inlet fixtures and manual inlet flow controls.
- Automatic air flow controls.

1.4 Distribution. The HVLE service is distributed to specified technicians benches and stationary laboratory equipment locations by a specially sized and equipped centrally piped distribution network designed for dry-line operation.

1.5 Performance. The system and the distribution network are designed to function as per USAFSAM-TR-86-25, "Dental Laboratory Respiratory Hazards and Vacuum Performance Parameters," and as specified herein.

1.6 Guidelines. The guidelines provided in this document are minimum requirements for safe, proficient, reliable, and cost-effective HVLE systems.

The information provided is applicable to all HVLE systems in new construction and in system replacement projects. The information is intended to supplement Air Force Regulation 88-50, "Criteria for Design and Construction of Air Force Health Facilities."

1.7 System and Distribution Network. The HVLE system and associated distribution network are not used in flammable gas locations, are not used to scavenge flammable anesthetic gas, and are not installed in inpatient treatment areas. Therefore, the system and distribution network are not within the jurisdiction of National Fire Protection Association (NFPA) Standard 99.

2. DEFINITIONS

2.1 Air Flow. Air-flow references are in standard cubic feet per minute (SCFM).

2.2 Air Velocity. Air velocity references are in linear feet per minute or, most commonly, feet per minute (FPM).

2.3 Automatic Trunk-Line Flow Control Valve. An automatically compensating valve located at the extreme upstream end of the HVLE trunk line(s), actuated by small changes in negative pressure caused by opening or closing of riser inlet fixtures. The function of this valve is to maintain the specified duct velocity (3500 FPM) in the trunk line for effective transport of dust to the collector/separator/filter unit.

2.4 Backward Curve Impellers. Turboexhauster impellers whose vanes are arched across the impeller radius so that the convex curve faces the direction of rotation to enhance turboexhauster efficiency and performance.

2.5 Central Collector/Separator/Filter Unit. A negative pressure vessel, located in-line between the HVLE trunk line(s) and the turboexhauster, is designed to separate solid debris from air and collect the debris and filter outgoing air before entering the turboexhauster.

2.6 Centrally Piped Distribution Network. The central plumbing for the distribution of HVLE service throughout the dental laboratory, beginning with the riser inlet fixtures and terminating at the point of connection to the central collector/separator/filter unit, and designed and equipped as specified.

2.7 Composite Dental Facility. A dental facility (clinic) which is physically and mechanically attached to a medical facility.

2.8 Continuous Trunk Line. A single HVLE trunk line running between the turboexhauster and the automatic trunk-line flow control (ATFC) valve, and to which all risers are connected.

2.9 Dental Laboratory. Specifically designed and equipped room within a dental facility for fabrication of prosthodontic appliances (does not include the ceramics laboratory).

2.10 Dry-Line Operation. Piped transport of a combination of air and dry debris.

2.11 High-Volume Laboratory Evacuation System. The assembly of components specifically designed for the scavenging and collecting of grinding and finishing debris generated in the dental laboratory; consisting of a turboexhauster, collector/separator/filtering unit and all electrical, mechanical, fluidic and noise controls, components and interconnections specified and/or required, including the HVLE centrally piped distribution network and components.

2.12 Inlet Fixture. Specified riser end fitting providing access to the HVLE service for specified dental laboratory equipment.

2.13 Isolation Pads. Blocks or pads of resilient material used to support equipment frames or bases to prevent transmission of equipment vibration to the structural parts of the facility.

2.14 Looped Trunk Lines. Several continuous HVLE trunk lines with a common origin point (the turboexhauster) and a common termination point (the ATFC valve).

2.15 Manifold. A short length of nominally sized pipe used as a common connection point for several trunk lines to the turboexhauster or to the ATFC valve.

2.16 Pipe Isolators. Flexible, resilient, band-clamped sleeves or couplings used for plumbing connections to equipment to prevent transmission of equipment vibration to connected pipes and components.

2.17 Risers. The upstream end of the HVLE centrally piped distribution network consisting of 1-1/2 in. nominally sized pipes which connect the inlet fixture to the HVLE trunk line.

2.18 Riser Flow Control Valve. A manual, minimal restriction in-line valve located on each HVLE riser to provide regulation of air flow through the riser inlet fixture and to assist in balancing the system.

2.19 Silencer. An in-line device to provide abatement of air-generated noise without line restriction or back pressure.

2.20 Trunk Line. The nominal-sized pipe which serves as the main or major line of the HVLE centrally piped distribution network; to which all risers are connected; and which connects the turboexhauster to the ATFC valve.

2.21 Turboexhauster. A vacuum-producing, driven turbine designed, sized and equipped as specified, and used as the vacuum source for the HVLE system.

2.22 Vacuum Pressure. The negative pressure generated in the HVLE system by the turboexhauster and measured in inches of mercury (in. Hg).

3. REQUIREMENTS

3.1 Equipment Design. The HVLE system and HVLE distribution network are designed to support the central dust collection requirements of the dental laboratory and shall not be used for any other purpose.

3.2 Equipment Components. The HVLE system and central distribution network shall consist of standard manufactured products, complete with all devices normally furnished and devices required herein. When devices normally furnished conflict with devices required herein, the devices required herein shall have precedence. The HVLE system shall be supplied by a manufacturer regularly engaged in manufacturing commercially available, industrial quality central vacuum systems for at least 2 years before bid opening. The manufacturer shall supply a complete system assembly and serve as a single source for spare parts and service for all components in the system regardless of original vendor.

3.3 Installation Location. The HVLE system turboexhauster shall be installed in a well-ventilated mechanical space within the served facility and within 100 ft of the collector/separator/filter or in a separate mechanical space not more than 100 ft from the collector/separator/filter. The system central collector/separator/filter vessel shall be installed directly adjacent to the dental laboratory in a separate acoustically treated closet space. For retrofit projects, when no space is available adjacent to the laboratory the central collector/separator/filter shall be installed directly adjacent to the turboexhauster, not to exceed 50 ft linear distance from the dental laboratory.

3.4 Performance Requirements.

3.4.1 System Inlets. All HVLE system inlets shall operate with an air intake rate of not less than 40 CFM and not more than 45 CFM.

3.4.2 Distribution Network. All ducts in the distribution network, including risers and trunk lines, shall operate with a centerline velocity of not less than 3500 FPM.

3.5 Performance Measurement. Performance of the HVLE system and the associated distribution network shall be measured by the specified testing procedure.

3.6 HVLE System. The HVLE system shall include, but not be limited to, the following major components:

- Central, collector/separator/filter unit
- Turboexhauster
- Isolation pads
- Exhaust silencer
- Plumbing isolators
- Electrical controls and enclosure
- Remote control panel

3.6.1 Central Collector/Separator/Filter Unit

3.6.1.1 The central unit shall be a negative pressure vessel certified by the system supplier to withstand a constant negative pressure of not less than 8 in. Hg. The unit shall be of steel with all-welded construction. The exterior of the unit shall have a painted finish to resist corrosion. The unit vacuum inlet shall be tangential to the separator body to effect cyclonic separation of air from debris.

3.6.1.2 The upper section of the separator shall be equipped with a reusable bag filter system configured to clean the air leaving the cyclonic separator chamber before entry of air into the turboexhauster. Minimum bag area shall be according to the number of laboratory technicians assigned as follows:

No. of Technicians	Filter Bag Area (ft^2)
1 - 4	60
5 - 10	100
11 - 20	300

The separator shall be equipped with a manually controlled, electric powered bag shaker or agitating system mounted on the exterior of the separator, with mechanical connection to the filter bag assembly. The agitation shall effectively remove debris impacted on the outer surface of the filter bags to maintain efficiency. The upper section of the separator shall be equipped with a screw or bolt fastened access panel to permit filter bag inspection and service.

3.6.1.3 The lower section of the separator shall be equipped with a removable debris collector. The collector shall be equipped with casters and a pivoting bale-type handle to facilitate handling and emptying.

3.6.2 Turboexhauster.

3.6.2.1 The HVLE system for base-level laboratories shall contain 1 turboexhauster. Large area dental laboratories (ADLs) shall use 1 turboexhauster unless layout and size dictate otherwise, in which case 2 turboexhausters shall be justified.

3.6.2.2 The turboexhauster shall have a minimum capability to produce the specified inlet performance and the specified duct velocity while operating not less than 70% of the inlets simultaneously.

3.6.2.3 Line losses caused by the HVLE distribution network shall be compensated by adjustment of the turboexhauster capability.

3.6.2.4 Power to operate the turboexhauster shall be in direct proportion to the volume of air exhausted and shall not exceed the normal motor rating.

3.6.2.5 The vacuum produced shall be substantially constant throughout the operating volume range of the turboexhauster regardless of the number of simultaneously operating inlets not to exceed the calculated design performance (see para 3.4).

3.6.2.6 The turboexhauster shall produce its certified volume and vacuum at the above-sea-level altitude of the installation site; shall be tested and measured by the manufacturer before delivery, and shall be performance-certified (capacity and vacuum) as indicated by an equipment plate permanently attached to the turboexhauster.

3.6.2.7 The turboexhauster shall be a self-governing, centrifugal type; shall be either single or multistage; and shall be of either inboard or outboard bearing design. The turboexhauster shall operate at a speed not to exceed 3500 revolutions per minute (rpm) and shall be connected to its driving motor by either direct drive or by a multiple belt/pulley system. When a belt/pulley system or a flexible coupling is used, a steel coupling guard encompassing the coupling system shall be installed between the motor and turboexhauster. The guard shall be removable to permit unrestricted access to belts and pulleys or flexible coupling for service.

3.6.2.8 To reduce bearing lubricant temperature, a guarded fan shall be connected directly to the exhauster shaft adjacent to the exhauster shaft bearings, and shall create a flow of ambient air over the bearing carrier while the unit is operating.

3.6.2.9 Turboexhauster cases and end plates (inlet and exhaust heads included) shall be constructed of either heavy-gauge sheet steel rigidly welded at all seams and sections, or of cast gray iron. Sheet steel end plates shall be either concave or convex for flex resistance. Exhaust connections shall be tangential to the case or centered on the turboexhauster shaft centerline; all connections shall be sized to allow free air movement through the exhauster without flow restriction.

3.6.2.10 Internal moving parts of the turboexhauster shall be constructed with not less than 0.125-in. clearance throughout to prevent damage by transient particulates. Impellers shall be constructed by built-up sheet metal, smooth on all surfaces to prevent imbalance by uneven dust deposits. Impellers shall be of the backward curved design to provide optimal performance over a wide range of volume requirements. Impellers shall be securely attached to the exhauster shaft by setscrews or clamps of high-tensile material. Each impeller shall be balanced individually. The complete assembly, with motor, shall not exceed 1.4 mils of vibration when given a running test.

3.6.2.11 The turboexhauster and its drive motor shall be mounted to a common frame of welded steel as an assembly.

3.6.2.12 The drive motor for the turboexhauster shall be a standard National Electrical Manufacturers' Association (NEMA) 3500 rpm, T-frame, open drip-proof design; rated 200, 230 or 460 VAC, 60 Hz, three-phase; with seal- or lubricatable-type bearings. Operational temperature rise of the motor shall not exceed 40°C (104°F). All motors shall be high-efficiency types, as classified by NEMA criteria, and shall be rated for continuous duty.

3.6.2.13 The input of each turboexhauster shall have an adjustable air-volume control valve (ingestion gate) to prevent accidental motor overload and to provide a means of adjusting the upper design capacity limit. Maximum allowable setting of this valve shall be marked or provided with a stop as part of the certification procedure (para 3.6.2.6). The volume-control valve shall be built in or immediately adjacent to the first or input stage of the turboexhauster, and shall be present by the manufacturer during certification procedures. The volume-control valve shall be a butterfly-type to minimize air turbulence.

3.6.2.14 No valves other than those specified herein shall be permitted in the system interconnecting air handling plumbing or in the system exhaust ducting.

3.6.2.15 Each turboexhauster/motor assembly frame shall be mounted on resilient isolator pads which shall be furnished by the system manufacturer. The pads shall not be fastened to the facility floor. Vibration transmission shall be limited to less than 5% of the lowest frequency of vibration.

3.6.2.16 Pipe isolators shall be furnished by the system manufacturer and shall be used for all plumbing and system component interconnections to the turboexhauster inlets and outlets for control of vibration transfer.

3.6.2.17 The turboexhauster output shall be provided with an air-discharge silencer of the open bore expansion type. No interior baffling shall be permitted. The silencer shall attenuate exhaust air noise to a level below 85 dBA.

3.6.2.18 Exhaust extension shall be to the facility exterior through metal ducting with no bends or turns.

3.6.3. Electrical Controls.

3.6.3.1 The electrical system shall be installed by the latest edition of the National Electric Code and/or local regulations.

3.6.3.2 The turboexhauster shall be equipped with electrical controls and enclosure, to include a combination across-the-line magnetic starter with time-delay fused disconnects; a running hour meter; a two-button start-stop switch; and a warning light and audible alarm to indicate shutdown due to fuse failure.

3.6.3.3 Electrical controls shall include a complete low-voltage control function with labeled remote control panel for remote operation and monitoring of the turboexhauster.

3.6.3.4 The labeled low-voltage remote control panel shall contain an on-off switch for manual switching of the turboexhauster; pilot light to indicate operation; and a certified vacuum gage (graduated in inches of H_2O) to monitor vacuum pressure in the system. The gage shall be connected to indicate vacuum pressure in the trunk line near the ATFC valve (para 3.7.5).

3.6.3.5 The labeled remote control panel shall be located in the dental laboratory. Under no circumstances shall the remote control panel be located in the mechanical room housing the turboexhauster.

3.7 Centrally Piped Distribution System. The HVLE centrally piped distribution network shall include, but not be limited to, the following major components:

- Inlet fixtures
- Piping and fittings
- Riser flow control valves
- Automatic trunk-line flow control valve

3.7.1 Inlet Fixtures. Inlet fixtures shall be standard commercial grade 2-in. vacuum inlet valves with 2-in. female slip-joint connection for hose adaptors. Inlet fixtures shall be equipped with positive sealing hinged covers. No audible air leak from the closed fixture shall be acceptable when the system is operating. One hose adaptor shall be supplied with each inlet valve, sized according to the requirements of the equipment specified in the laboratory equipment list. One inlet fixture shall be provided for each HVLE input location indicated by the laboratory utilities layout. Inlet fixtures shall be installed on the front face of the casework service ledge unless otherwise specified for special equipment vacuum connection.

3.7.2 Adaptors. The contractor shall furnish all fittings to adapt 2-in. inlets to the equipment attached.

3.7.3 Piping and Fittings. All piping and fittings shall be acrylonitrile butyl styrene (ABS) or polyvinyl chloride (PVC), conforming to schedule 40 or class 200 specifications.

3.7.4 Fittings. All fittings shall be long-radius bend types for turns and wye types for branching. Attachments of risers to inlet fixtures are omitted due to space restriction in the service ledge. For small bore piping for which long-radius bends are not available, two 45-degree bends shall be substituted for 90-degree turning.

3.7.5 Risers and Riser Flow Control Valves. The centrally piped distribution network shall be made up of risers and trunk lines. All risers shall be 1-1/2 in. nominal diameter pipe; shall begin at the connection to the inlet fixture; and shall terminate at the connection to the trunk line. Each riser shall be equipped with a manual in-line valve, installed not less than 24-in. downstream from the orifice of the inlet fixture. The cross-sectional area of the bore of the valve shall not be less than that of the riser. These riser flow control valves shall be used to balance air flow through the inlet fixture.

3.7.6 Trunk Lines and Automatic Trunk-Line Flow Control Valves. Trunk lines shall be sized to provide the total intake of not less than 70% of the inlets connected and to maintain the specified duct velocity. Since trunk-line size varies with distribution network design and laboratory size

(number of inlets), trunk-line size shall be calculated for each individual HVLE system. Trunk lines shall begin at the connection to the ATFC valve (or valve manifold) and shall terminate at the connection to the turboexhauster (or turboexhauster manifold). The ATFC valve shall be designed and installed to automatically maintain the specified duct velocity (see para 3.4.3) in the trunk lines when various numbers of inlets (up to 70% total inlets) are in use. The ATFC valve shall be equipped with a silencer that shall attenuate intake air noise to not more than 84 dBA and shall be located and installed so that all intake air shall be drawn from the exterior of the facility.

3.7.7 Riser Connections and Trunk Layout. All risers shall be individually connected to trunk lines between the turboexhauster and the ATFC valve. No dead-end trunks or branches shall be permitted. Trunk line layout shall be either continuous or looped with ATFC valves. Looped trunks shall be either single or multiple. More than one ATFC valve shall be used when justified by trunk line layout requirements.

3.8 System Inspection, Start-up and Testing.

3.8.1 The installer shall provide a factory-trained technical representative who shall inspect the system and distribution network, assist in start-up and testing, and provide training to the personnel having maintenance responsibility.

3.8.2 The installer shall provide all testing materials, instruments, and equipment. Measuring instruments shall have current certification labels traceable to the National Bureau of Standards.

3.8.3 The HVLE system and distribution network shall be tested for the air flow and air velocity requirements specified. Testing shall be performed after the installation inspection; initial start-up; and a 4-h run-in period on the turboexhauster, operating with an air volume load equal to 70% of the laboratory inlets operating simultaneously. During the run-in period, the system shall be checked for overheating every hour.

3.8.4. The turboexhauster shall be started and allowed to run for 30 min prior to measurement of inlet and duct performance.

3.8.5 Centerline velocity in risers and trunk lines shall be measured with a probe-type anemometer. Holes sized approximately for the introduction of the anemometer probe shall be drilled in the walls of risers and trunk lines and shall be closed with removable threaded seals to permit use in future testing. Anemometer probe access holes in risers shall be 10 riser diameters distant downstream from the face of the inlet fixture. Anemometer probe access holes in trunk lines shall be 10 trunk-line diameters distance upstream from the point of attachment of the trunk line or manifold to collector/separator/filter unit. Volume flow rates (CFM) for inlets shall be calculated using the following formula:

$$Q = 0.9 \times V \times A$$

Where: Q = Flow in CFM
V = Centerline velocity in FPM
A = Cross-sectional area of duct in square feet

3.8.6 Specified inlet and trunk-line performance shall be demonstrated by measurements with 70% of the inlets operating simultaneously. When all inlet and trunk line performance is as just specified, the electrical current draw of the turboexhauster drive motor shall be measured. Electrical draw shall not exceed the motor rating.

4. OUT-OF-CONUS INSTALLATIONS

For equipment intended specifically for installations outside of the continental United States (overseas bases), the vacuum-source drive-motor frequency and voltage requirements of this specification shall be changed to ensure compatibility with on-site electrical supply configurations. Such modifications shall not detract from equipment longevity or performance.

5. DOCUMENTATION

5.1 Instructions. The contractor shall supply two complete sets of the manufacturer's operating and maintenance instructions as specified in paragraph 5.2 to the local maintenance organization who shall be responsible for system maintenance. Bound set covers shall be labeled with the system name, building number, contractor's name, and contract number.

5.2 General Information.

5.2.1 The manual shall include an overall description and purpose of the system or equipment. The function and purpose of each system component shall be described. The description shall include the intended use, capabilities, and limitations of the system or equipment. If the manual covers more than one model of a system or equipment, or systems or equipment modified by field change, a description of the differences shall be provided. Quick-reference data shall be included and shall describe technical or design characteristics of the equipment. Examples of such data are:

- Descriptive (nameplate) data necessary to identify manufacturer, type, and model.

- Functional characteristics, such as: power and frequency requirement, voltage and amperage demands, outputs, and modes of operation.

- Rated outputs, such as: horsepower, CFM, and rpm.

- Special characteristics, such as: operating temperatures, pressure, heat dissipation, and humidity.

5.2.2 A warning page, consisting of the more vital warnings extracted from those shown throughout the manual, shall be assembled and placed on the inside cover or in front of the initial page(s) of the manual (see para 5.2.7).

5.2.3 Operating instructions shall include routine and emergency procedures (manual and automatic) and safety precautions. Limits to be observed in the starting, operating, stopping, or shutting down of the equipment or system shall be provided. Adequate illustrative material shall be provided to identify and locate operating controls and indicating devices.

The function of each operating control and indicating device shall be included. Emergency operating instructions shall include alternate procedures to be followed when normal operation is not possible because of emergency conditions, such as power or lubricating oil failure. Emergency operating instructions and procedures shall be located for quick and ready reference.

5.2.4 Preventive maintenance information shall be provided. Use of special tools, materials, and test equipment shall be specified, including model/type designation, as appropriate. The following procedures shall be stressed, if applicable.

5.2.4.1 Periodic cleaning and lubrication information, types of cleaning agents or lubricants required, recommended intervals, such as monthly, quarterly, semiannually, or hours of operation shall be provided. Application points and capacity (required amounts) shall be identified. Pictorial format for lubrication is desirable. Cleaning and lubrication required during repair, replacement, and reassembly shall also be covered (see para 5.2.6).

5.2.4.2 Inspection. Instructions for inspection of equipment for damage and wear shall be included. Tabular or chart format is preferred and shall include, where applicable, allowable service limits, wear,backlash, end play, length and depth of scoring, and balance. These instructions shall be sufficiently complete to service as standards by which experienced technicians may determine when parts may be continued in use and when they must be replaced.

5.2.4.3 Instructions shall be included for verification of system performance. The location of test connections and the values expected at these points shall be included, preferably in illustrated format. Data shall include a list of equipment required to accomplish the verification, such as temperature, vacuum, pressure, hydraulic, or pneumatic gages.

5.2.5 Failure that might occur during operation of equipment shall be listed. Troubleshooting data and fault isolation techniques shall state: (a) the indication or symptom of trouble, (b) the instructions necessary, including test hookups, to determine the cause, (c) special tools and equipment, and (d) methods for returning the equipment to operating conditions. Information may be given in chart or tabular format with appropriate headings.

5.2.6 Instructions shall be provided for all removal, repair, adjustment, and replacement procedures. Exploded and sectional views giving details of assemblies shall be provided, as necessary, to clarify the text. For mechanical items, dimensional information with tolerances, clearances, wear limits, maximum bolt-down torques, and in-place balancing or other means of reducing noise level, if required, shall be supplied.

5.2.7 Notes, cautions, and warnings shall be used to emphasize important and critical instructions where necessary. Notes, cautions, and warnings shall immediately precede the applicable instructions, and shall be selected as follows:

NOTE: Concerns an operating procedure or condition which should be highlighted.

CAUTION: Concerns an operating procedure or practice which, if not strictly observed, could result in damage to, or destruction of equipment.

WARNING: Concerns an operating procedure or practice which, if not strictly observed, could result in injury to personnel or loss of life.

5.2.8 Manuals shall contain all illustrations necessary to locate and identify components of operational and maintenance significance. Where necessary for clarity, illustrations shall show configuration, and the removal and disassembly of parts. The following types of diagrams shall be included: Schematic diagrams which show the arrangement of component devices or parts; wiring diagrams which show the connections of the circuit arrangement; and schematic piping diagrams which show the interconnection of components, of piping, tubing, or hose, and the direction of air flow.

5.2.9 Circuit diagrams for electronic units shall be provided to support maintenance and troubleshooting. Circuit diagrams shall cross-reference repair parts shown in test tables and parts lists. The function name of each stage or circuit, primary signal flow, test points, wave forms with pertinent characteristics, electrical characteristics of parts name of each variable control, input and output connectors/terminals, voltages, and signals shall be specified. Voltage and resistance values measured with controls set for normal operation shall be shown for significant points, such as terminal boards, and connectors. Interconnecting cable diagrams shall be furnished to show TO-FROM information, including any intermediate connections. Block diagrams shall be provided to support installation instructions, but shall not be substituted for necessary schematic diagrams.

5.2.10 Parts lists shall provide positive identification of parts necessary for support of the systems or equipment and shall include sufficient information to enable maintenance personnel to requisition replacement parts.

5.2.11 Clear and legible illustrations shall be provided to identify component parts and parts' relationships. Part numbers and names may be shown on illustrations or separately listed. When the illustrations omit the part numbers and names, both the illustrations and separate listing shall cross-reference illustrated part to listed part.

5.3 Format.

5.3.1 Wherever possible, commercial manuals will be incorporated without change in either content or format. The commercial manuals may be bound without disassembly in the facility manual or may be disassembled and applicable portions incorporated into existing manuals.

5.3.2 The manual may be divided into volumes to prevent the manual from becoming too bulky.

5.3.3 The text shall be specific, concise, and clearly worded to be easily understood by personnel involved in the operation, maintenance, and repair of the equipment.

5.3.4 The manual shall be oriented toward operation, maintenance, and repair of the equipment by the operators and maintenance personnel without the assistance of a manufacturer's representative.

5.4 Manuscript Review. Draft manuscript copies, in the format and number as specified, shall be provided to the Government for review (see para 5). Operating and maintenance procedures, including checkout, calibration, alignment, scheduled removal and replacement instructions, and associated checklists shall be validated against the system (or equipment) in the presence of Government personnel.

5.5 Posted Instructions. Besides the operation and maintenance manuals, the following diagrams and instructions shall be furnished and installed, framed under glass or approved plastic laminate, and permanently posted within view of the installed system:

- Complete layout diagram to include all wiring controls, system components, plumbing, valves, and regulators.
- Selective starting and stopping procedures.
- Checking procedure for normal operation.
- Abbreviated recommended preventive maintenance procedures.
- Emergency instructions.
- Warnings and precautions.

5.6 Field Instructions. After installation, start-up, testing, and acceptance of the system, the contractor shall be required to supply the services of a competent representative for not less than 4 h to instruct local maintenance and operating personnel in the proper operation and maintenance of the complete system.

6. CONCLUSIONS

This report includes the minimum requirements for the central dental high-volume laboratory evacuation (HVLE) systems and associated centrally plumbed distribution networks for use in USAF dental health facilities. The specifications were developed through joint evaluations by the Dental Investigation Service and the Occupational and Environmental Health Laboratory which established standards for dental clinics. (Reference USAFSAM-TR-86-25, "Dental Laboratory Respiratory Hazards and Vacuum Performance Parameters," Nov 1986.) Any questions should be directed to USAFSAM/NGD, Brooks AFB TX 78235-5301, AUTOVON 240-3502, Commercial (512) 536-3502.

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